Submitted to:
US EPA Region 8
Denver, CO

Submitted by:
Atlantic Richfield Company
Butte, MT
August 29, 2011

Investigation Plan for Collapsed Adit Area at St. Louis Tunnel

Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

Atlantic Richfield Company

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August 29, 2011

Mr. Steven Way
On-Scene Coordinator
Emergency Response Program (8EPR-SA)
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Subject: Investigation Plan for Collapsed Adit Area at St. Louis Tunnel
Rico-Argentine Mine Site – Rico Tunnels
Operable Unit OU01 Rico, Colorado

Dear Mr. Way,

Please find enclosed three (3) copies of the *Investigation Plan for Collapsed Adit Area at St. Louis Tunnel*, dated August 29, 2011. Atlantic Richfield is submitting the *Plan* responsive to Task B of the Removal Action Work Plan, Rico-Argentine Mine Site – Rico Tunnels, Operable Unit OU01 Rico, Colorado, dated March 9, 2011.

If you have any questions, please feel free to contact me at 406-782-9964.

Sincerely,

Anthony R. Brown

Anthony R. Brown, P.E.
Project Manager
Atlantic Richfield Company

Enclosures

cc: R. Halsey, AR
C. Stilwell, AR
S. Dischler, AR
T. Moore, AR
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Table of Contents

Contents

List of Figures

List of Photographs

Investigation Plan

for

Collapsed Adit Area at St. Louis Tunnel

at

Rico-Argentine Mine Site – Rico Tunnels Operable Unit OU01 Rico, Colorado

August 29, 2011

1.0 Objectives

The primary objectives of this Adit Investigation Plan (AIP) are to: 1) investigate the condition of the collapsed portion of the adit and how it interfaces with competent rock at the brow of CHC Hill; 2) assess the possible accumulation of settled solids and water build-up behind the existing blockage in the collapsed area; and 3) provide information to support design of a hydraulic control system for discharges from the St. Louis Tunnel. Investigations to support achieving these objectives are focused on collecting, controlling, and conveying the adit flow from its current point of discharge to the water treatment facility, currently assumed to be upgradient of the existing Pond 18.

If competent bedrock is not encountered in the work planned herein, further investigations may be proposed to support evaluation of access to and rehabilitation of the St. Louis Tunnel to a point where the tunnel encounters reasonably competent bedrock (i.e., the brow of CHC Hill). Additional information could be developed in a subsequent phase of investigation to support accessing the tunnel into the northwest and southeast cross-cuts, if desired and if feasible. This future work of accessing the intersection of the main St. Louis Tunnel and the cross-cuts would allow direct measurement of flow contributions from the Argentine-Blaine and interconnected workings to the southeast, and the Mountain Springs-Wellington and other interconnected workings to the northwest. This additional work, if considered further as part of a future phase of the source reduction efforts, will be discussed with EPA and the State once the adit opening is stabilized.

If consideration of temporary in-mine storage of currently discharging mine water to regulate seasonal flows is contemplated, then subsequent investigations would need to address issues including the following:

1) The extent and location of available storage volume in the mine workings (i.e., open versus collapsed workings);
2) Potential for destabilizing existing colluvial, talus and landslide deposits blanketing the lower slopes of CHC Hill;
3) Potential for discharges through unconsolidated deposits, faults, fractures and joints, and/or unknown or inadequately sealed historic mine openings; and
4) Obtaining a better understanding of the hydrogeologic conditions and overall water balance within and conveyed through the underground workings.

The objectives described above for the current study will be met by implementing the tasks described in the subsequent sections of this AIP. Note that the tasks are described in the general order in which they will be performed with the understanding that some of the tasks may overlap to some degree. Subsequent tasks may change somewhat based in part on the results of precedent tasks.

2.0 Background

A portion of the St. Louis Tunnel immediately behind the masonry block portal structure has collapsed, apparently due to borrowing of the overlying colluvium/talus deposits (see Figures 1 and 2). The visible portion of the collapse is approximately 200 feet long. A black and white aerial photograph reportedly taken in 1956 shows a major excavation in the area of the existing cut slope above the collapsed tunnel (see Photo 1). When examined in August 2006, the condition at the bottom of the cut was a tangle of broken timbers and lagging among a heterogeneous mix of sand to boulder-size blocks resulting in unstable voids of varying size and shape (see Photos 2 through 6). The discharge from the tunnel was impeded at the upgradient end of the collapse such that flow was observed at the approximate tunnel roof level. This flow then worked its way through the collapsed material to exit at the original tunnel floor grade in the portal.

The reason that the area overlying the down-gradient end of the St. Louis Tunnel was originally excavated (as visible in the 1956 aerial photo – Photo 1) is unknown. One theory is that the excavation was made to substantially reduce or eliminate what may have been frequent maintenance of the support in the portion of the tunnel through the colluvium/talus mantling the lower slope of CHC Hill, and generate borrow for other facillties on site in the process. If this was the case, it may suggest that the brow of CHC Hill where Hermosa Formation bedrock is present may not be too far into the hill at the east end of the excavation. This is generally consistent with projection of the mapped contact of Hermosa Formation and colluviums from published small-scale (1:24000) geologic mapping (Pratt, et al., 1969)[1]. Bedrock is not readily apparent in photographs of the upper slope of the excavation where it would be anticipated from the small-scale geologic map (see Photos 8 and 9 relative to the mapped contact of Qtw and P_{hl} on Figures 1 and 2). It appears that the original excavation over the tunnel was cut with rough benches as would have been the common practice for a mining operation especially in unconsolidated material. The current slopes are much more uniformly sloped (see Photos 7 through 9). It is unknown if additional excavation was performed to remove the benches or if natural weathering and slope processes removed the benches over time resulting in accumulation of material on the slopes and in the floor of the cut. If so, that material may obscure the sedimentary Hermosa Formation bedrock projected to occur in the upper portion of the excavation slope as described above.

A reduction in dissolved iron in the adit discharge was observed in a previous undocumented review of available water quality data as having occurred sometime around the mid-1990s. As a result of the conditions observed in the collapsed area in 2006 and the change in water quality (particularly dissolved Fe) it has been inferred that the accumulation of debris near the currently buried adit opening resulted in conditions conducive to precipitation of iron and settling of solids within the St. Louis Tunnel. Based on the

[1] Pratt, Walden P., McKnight, Edwin T., and DeHon, Rene A. 1969. Geologic Map of the Rico Quadrangle, Dolores and Montezuma Counties, Colorado: Department of the Interior, U.S. Geological Survey. 1:24,000.

magnitude of the apparent observed change in dissolved iron it is estimated that much of the main tunnel to and into the cross-cuts could have been filled with iron precipitate over a number of years.

3.0 Investigation Actions

3.1 Compile, Review and Evaluate Existing Data

Existing information on the grade and alignment of the St. Louis Tunnel (from existing mine plans) and on the geology of the portal area from published geologic mapping and reports, and the results of previous and upcoming additional site exploration, will be reviewed and evaluated to support the investigations under this task and the preliminary design of hydraulic control structures under Work Plan Task D.

A search for available historic aerial photographs and other remote imagery will be made to supplement the 1956 photo noted previously and color aerial photos taken in 1980 and 2004 as part of preparation of topographic maps of the St. Louis Ponds site. Any photos or imagery found will be reviewed for relevance and used as appropriate to support the investigations described herein and subsequent design of clean-up and stabilization of the collapsed adit area.

3.2 Detailed Survey and Site Reconnaissance

3.2.1 Collapsed Adit

A detailed site reconnaissance and topographic survey of the collapsed area will be conducted and a one (1) ft contour map will be prepared. The two primary objectives of this task are to: 1) document the current conditions in the collapsed area to support design of clean-up, slope stabilization and conveyance of tunnel discharge through this area; and 2) reconstruct the dimensions, location, bearing, and grade of this portion of the St. Louis Tunnel to retine the target location for the drilling described in Section 3.4 and possible subsequent in-mine investigations.

The survey will be performed using total station or survey-grade GPS unless it is determined that direct access onto the collapsed rubble is not safe. If conventional surveying proves infeasible then ground-based Lidar will be used. Set-up locations for the Lidar equipment appear feasible on the soil lead repository immediately north of the collapsed area (see Figure 1).

In addition to surveying the surface of the rubble, detailed panoramic digital photographs will be taken and video recorded with temporary bench marks for which coordinates and elevation are known. The presence, location (coordinates and elevation to the extent feasible), character (color, presence of suspended solids or turbidity), and estimated flow rate of visible flow or seepage within the collapsed area will be recorded to the extent safe and feasible. Remaining visible and accessible timber sets that appear reasonably in place will be located and dimensioned in detail. An attempt will also be made to hand auger and/or probe through less coarse-grained colluvium which has buried the tunnel crown at the upgradient end to the U-shaped excavation and through debris in the open collapsed portion of the tunnel in an attempt to tind the floor. All of this information will be used to establish the apparent tunnel bearing, roof elevation and tunnel width, and estimated tunnel floor elevation and grade.

The results of the site reconnaissance and topographic mapping will also be used to tinalize planning for the exploratory drilling program described in Section 3.4.

3.2.2 Excavation Slopes

The slopes of the excavation surrounding the collapsed area and the adjacent natural slopes will be examined in detail and samples collected for geotechnical testing to support evaluations of the stability of the existing slopes, and if necessary, to design long-term stabilization of those slopes. Information on the variation and general distribution of gradation of the talus/colluvial materials exposed will be recorded. Detailed engineering geologic mapping of the excavation and surrounding ground will be performed with a primary objective of identifying and mapping outcropping or near surface Hermosa Formation bedrock both within and adjacent to the excavation. Engineering geologic mapping on the excavation slope and steep colluvial/talus slopes will be performed using rappelling gear and/or other measures and equipment as necessary to ensure safety of the mapping personnel.

A long-reach tracked backhoe will be used to excavate test pits in the lower slopes of the excavation (see Figure 1), and bulk samples will be collected for geotechnical testing in the laboratory. The in-place moisture and density of the slope materials will be measured using a nuclear density gage where practical given the in-situ gradation of the material.

Observations will be recorded of instability on the excavated slope and/or on the surrounding natural slopes, such as tissures or cracks, scarps, raveling soils, tilted trees, trees growing with a bend in the trunk, areas of seepage, etc.

3.3 Resistivity Surveys

Ground resistivity surveys are planned on the slope above the collapsed area in an attempt to verify the projected location of the tunnel in order to retine the target for penetration of the tunnel by air track drilling and possibly a horizontal boring as described in Section 3.4. Resistivity is believed to provide the best chance of identifying the tunnel as a resistivity anomaly as compared to the surrounding talus/colluvium and possibly Hermosa Formation sedimentary rock and younger intrusive igneous rock. Preliminary locations for three (3) resistivity arrays are shown on Figures 1 and 2. Resistivity line R-1 is located at the toe of the excavated area where the tunnel is relatively shallow. This location will provide an indication of the applicability of the technique and of the nature of the signature to be expected on lines R-2 and R-3. Line R-2 is planned at the break in slope from about 1.7H:1V on the lower excavation slope (see Figure 2) approximately 70 feet above the projected location of the tunnel. Line R-3 is located at what appears to be a subtle sloping bench at the top of the excavated area surrounding the collapsed reach of the tunnel. The anticipated depth of the tunnel at this location is on the order of 180 feet. If successful, lines R-2 and R-3 will provide contirmation of the mine map that at least this lower end of the St. Louis Tunnel was constructed on a constant bearing and grade as projected from the information gathered by the work described in Sections 3.1 and 3.2.

3.4 Exploratory Drilling

3.4.1 Air-Track Drilling

Depending on the results of the tasks described in Sections 3.1 through 3.3, it is proposed to drill a linear array of exploratory holes along the projected alignment of the St. Louis Tunnel at the uphill end of the excavation area as shown on Figures 1 and 2. The objective of these drill holes is to identify to the extent possible the location of the crown and floor of the tunnel and the nature of the overlying and underiying materials (i.e., talus/colluvium versus bedrock).

Given the access constraints in this area it is proposed to use a small track-mounted air-track drill rig. An assessment will be made of the risks associated with this drilling prior to implementation, including raveling/rolling of rock debris from the surrounding excavation slopes and collapse of debris into the underiying remnants of the tunnel due to the imposed load of the drill rig. If necessary, the drill alignment would be offset from the tunnel alignment so that the drill rig would not be placed over the tunnel. The drill holes would be drilled at the appropriate angle from the vertical in this case to intercept the projected location of the tunnel. For holes to be drilled on the lower slope of the excavation area the drill will be angled from the vertical into the hillside in order to reach as far as practical back along the projected tunnel alignment. The holes will be cased as the drilling advances through talus/colluvium. If Hermosa Formation sedimentary bedrock is encountered it is not anticipated that those reaches of the holes would need to be cased.

Geotechnical sampling as the holes are advanced is not practical with this type of drilling so that information on the physical properties of the materials encountered will be based on drill action and the experience of the driller and the professional logging the drill hole and cuttings. The nature of the drill action (smooth, chattering, etc.), rate of penetration, color of the drill cuttings, and the presence of free water or precipitated metals sludge (e.g., iron red dog) in the drilling return will be recorded. Special attention will be paid if refusal or marked change in drill action or penetration rate is encountered. Note will be made if the drill action suggests having encountered a support timber (which may result in bouncing of the drill with very slow penetration).

If encountered, water and/or precipitation solids within the tunnel will be sampled through the drill hole casing. If an open tunnel and/or bedrock section are encountered, a borehole camera will be used to examine in situ conditions to the degree practical.

3.4.2 Horizontal Boring

An evaluation will be made immediately upon completion of the tasks described in Sections 3.1 through 3.2 and 3.4.1 as to the need and feasibility of drilling a horizontal boring to intersect the St. Louis Tunnel upgradient of the collapsed portion of the tunnel, ideally just into the brow of the hill (see Figures 1, 2, and 3). Assuming the need and feasibility are contirmed, a bore pit for the drilling rig would be constructed by grading at the toe of the waste rock slope just southwest of the collapsed area. The primary objective of this boring would be to observe if precipitated solids are encountered within the tunnel, either by discharges from the tunnel in the drill pipe, or by camera survey if no discharges occur. An additional objective would be to visually examine and digitally record the condition of the tunnel at the point of penetration by use of a remote-controlled borehole camera. A third objective will be to acquire core samples of any bedrock encountered during the drilling.

Drill pipe diameter will be selected in coordination with identitication of a suitable pipe inspection camera system. Pipe diameter as small as two (2) inches is feasible with a push system, but deployment length is typically limited to 200-300 feet. A crawler system typically requires at least a four (4)–inch pipe diameter, but length is not a limiting factor in this application. If drilling an exploratory boring is determined not feasible or if conditions in the tunnel remain uncertain even with an exploratory boring, then alternative further investigafions would be evaluated. These could include additional drilling use a skid-mounted rig secured to the excavation slope or staged, protected excavation of the collapsed portion of the adit. A key consideration in the evaluation of either of these approaches would be the technical feasibility and safety of the operations involved. Implementation of either of these approaches is not included in the scope of this AIP.

If encountered, precipitated metals solids and/or water at the level of the horizontal boring penetration of the tunnel wall above the collapsed area will be sampled through the horizontal boring casing.

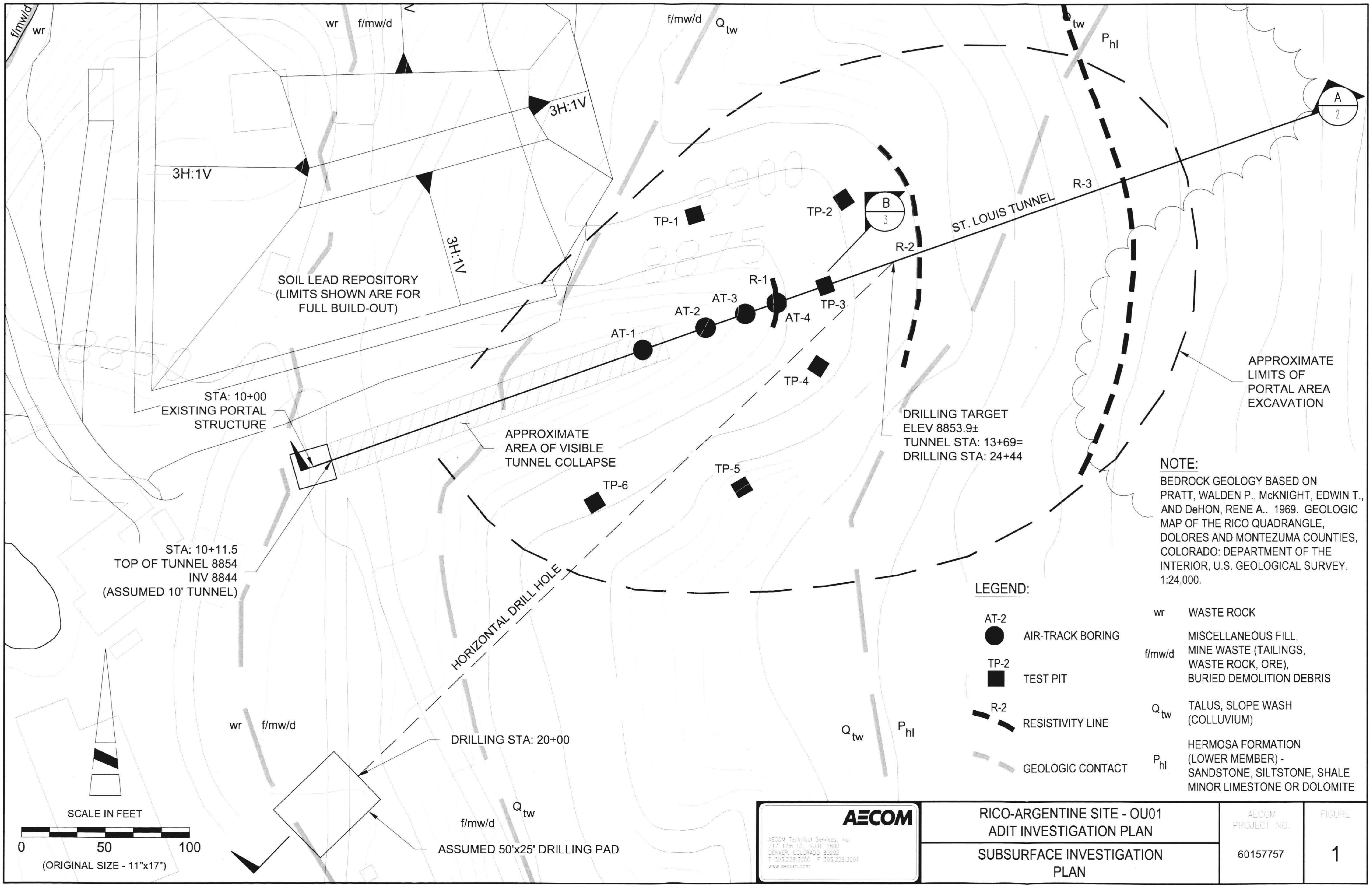
3.5 Laboratory Testing

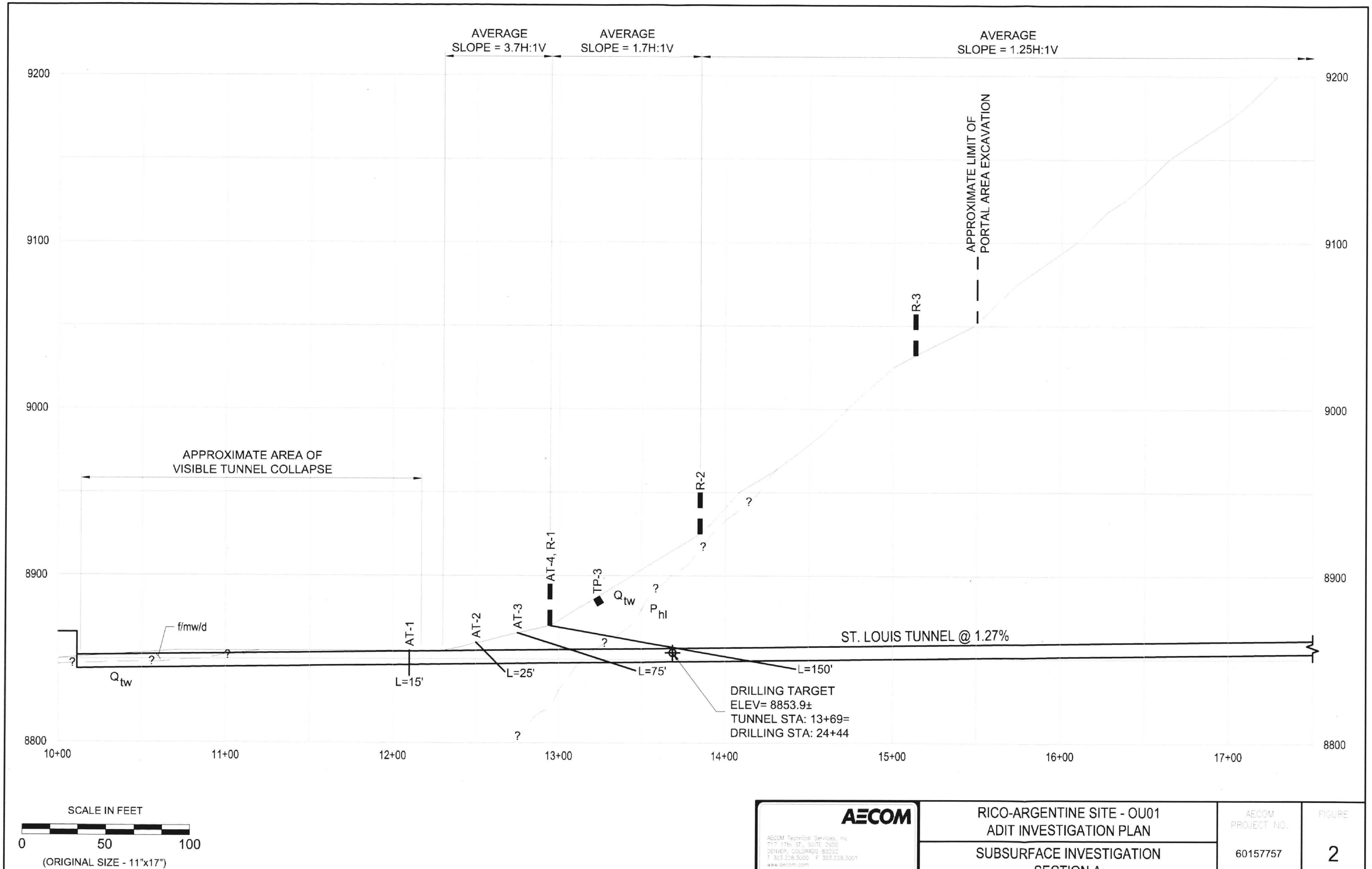
3.5.1 Geotechnical Testing

Samples from the test pits on the lower slopes of the excavation will be tested for index properties (moisture content, gradation, and if plastic, Atteberg limits) and for laboratory moisture-density relationship (i.e., Proctor density testing). In addition, direct shear or possibly triaxial shear strength testing will be performed on samples prepared in the laboratory to represent approximate in place density and/or use of similar materials as compacted fill. If rock core is acquired from the horizontal boring described in Secfion 3.4.2 appropriate tesfing would be performed. Depending on the amount and characteristics of core recovered, testing may include specific gravity, chunk density, unconfined compressive strength, indirect splitting tensile strength, rock hardness by rebound hammer or Schmidt rebound hardness, and possibly Cerchar abrasivity index or punch penetration tesfing.

3.5.2 Water and Sludge Testing

Water samples, if any are collected, will be tested for the full suite of analytes for surface water presented in the project SAP and additional parameters to be identified and proposed for concurrence by EPA that may be helpful in assessing the possible source(s) of the water. If sludge samples are collected a suite of appropriate testing will be developed and implemented in cooperation with EPA.


wr
f/mw/d
3H:1V
3H:1V
3H:1V
SOIL LEAD REPOSITORY
(LIMITS SHOWN ARE FOR
FULL BUILD-OUT)
Q_{tw}
P_{hl}
8900
8875
8850
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
AT-1
AT-2
AT-3
AT-4
R-1
R-2
R-3
ST. LOUIS TUNNEL
A
2
B
3
STA: 10+00
EXISTING PORTAL
STRUCTURE
APPROXIMATE
AREA OF VISIBLE
TUNNEL COLLAPSE
DRILLING TARGET
ELEV 8853.9±
TUNNEL STA: 13+69=
DRILLING STA: 24+44
APPROXIMATE
LIMITS OF
PORTAL AREA
EXCAVATION
STA: 10+11.5
TOP OF TUNNEL 8854
INV 8844
(ASSUMED 10' TUNNEL)
HORIZONTAL DRILL HOLE
DRILLING STA: 20+00
ASSUMED 50'x25' DRILLING PAD
SCALE IN FEET
0
50
100
(ORIGINAL SIZE - 11"x17")
NOTE:
BEDROCK GEOLOGY BASED ON
PRATT, WALDEN P., McKNIGHT, EDWIN T.,
AND DeHON, RENE A.. 1969. GEOLOGIC
MAP OF THE RICO QUADRANGLE,
DOLORES AND MONTEZUMA COUNTIES,
COLORADO: DEPARTMENT OF THE
INTERIOR, U.S. GEOLOGICAL SURVEY.
1:24,000.
LEGEND:
AT-2
AIR-TRACK BORING
TP-2
TEST PIT
R-2
RESISTIVITY LINE
GEOLOGIC CONTACT
wr
WASTE ROCK
f/mw/d
MISCELLANEOUS FILL,
MINE WASTE (TAILINGS,
WASTE ROCK, ORE),
BURIED DEMOLITION DEBRIS
Q_{tw}
TALUS, SLOPE WASH
(COLLUVIUM)
P_{hl}
HERMOSA FORMATION
(LOWER MEMBER) -
SANDSTONE, SILTSTONE, SHALE
MINOR LIMESTONE OR DOLOMITE
AECOM
RICO-ARGENTINE SITE - OU01
ADIT INVESTIGATION PLAN
SUBSURFACE INVESTIGATION
PLAN
AECOM
PROJECT NO.
60157757
FIGURE
1



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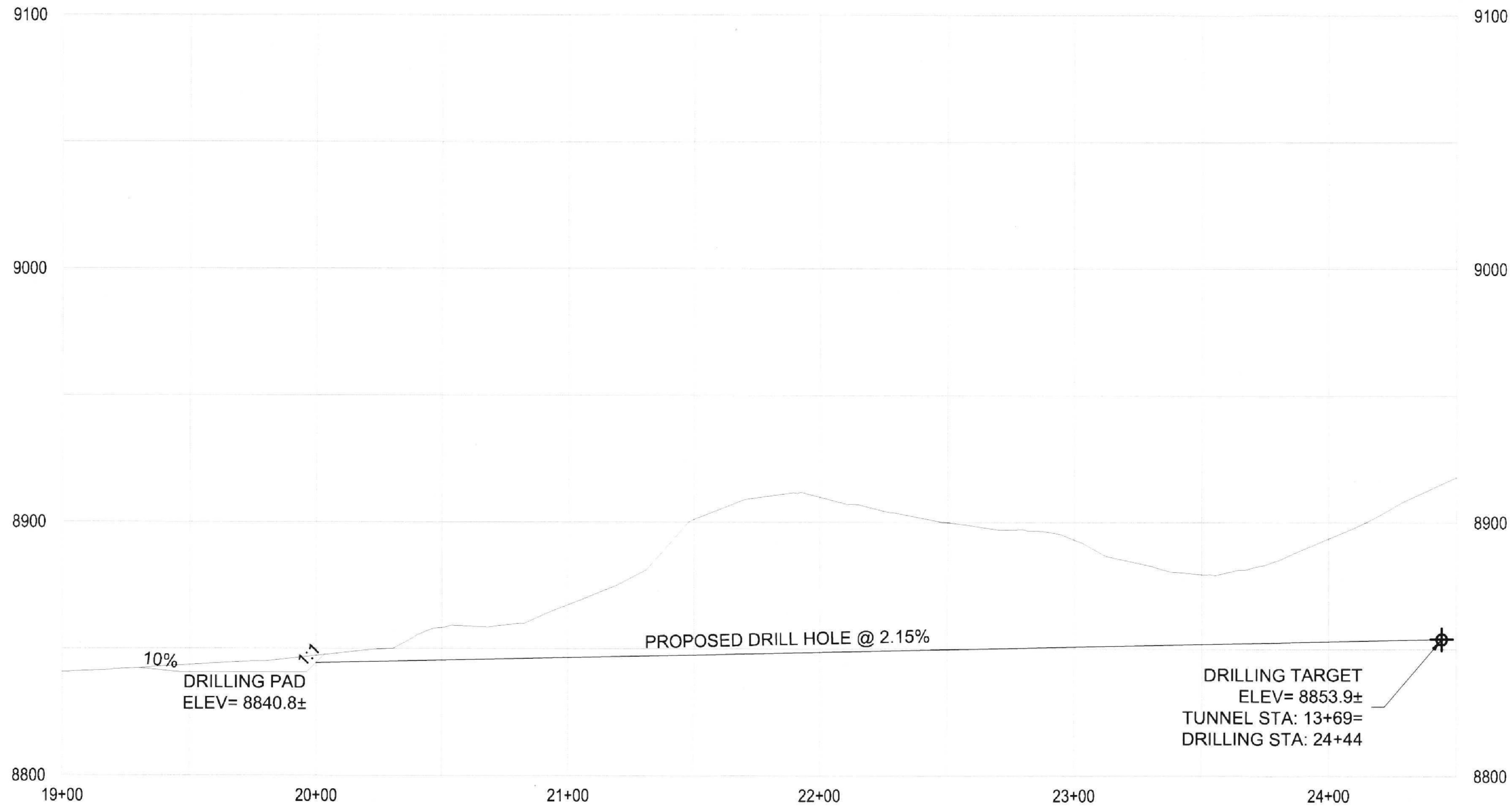
RICO-ARGENTINE SITE - OU01
ADIT INVESTIGATION PLAN

SUBSURFACE INVESTIGATION
SECTION A

AECOM PROJECT NO.	FIGURE
60157757	2



SCALE IN FEET

0 50 100

(ORIGINAL SIZE - 11"x17")

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RICO-ARGENTINE SITE - OU01 ADIT INVESTIGATION PLAN	AECOM PROJECT NO.	FIGURE
SUBSURFACE INVESTIGATION SECTION B	60157757	3

NOTE:
PHOTOGRAPHIC BASE:
1956 9"x9" BLACK AND
WHITE AERIAL PHOTGRAPH.

AECOM AECOM Technical Services, Inc. 717 17th ST., SUITE 2600 DENVER, COLORADO 80202 T 303.228.3000 F 303.228.3001 www.aecom.com	RICO-ARGENTINE SITE - OU01 ADIT INVESTIGATION PLAN	AECOM PROJECT NO.	PHOTO
	SUBSURFACE INVESTIGATION PLAN	60157757	1

Photo 2 - Existing portal structure

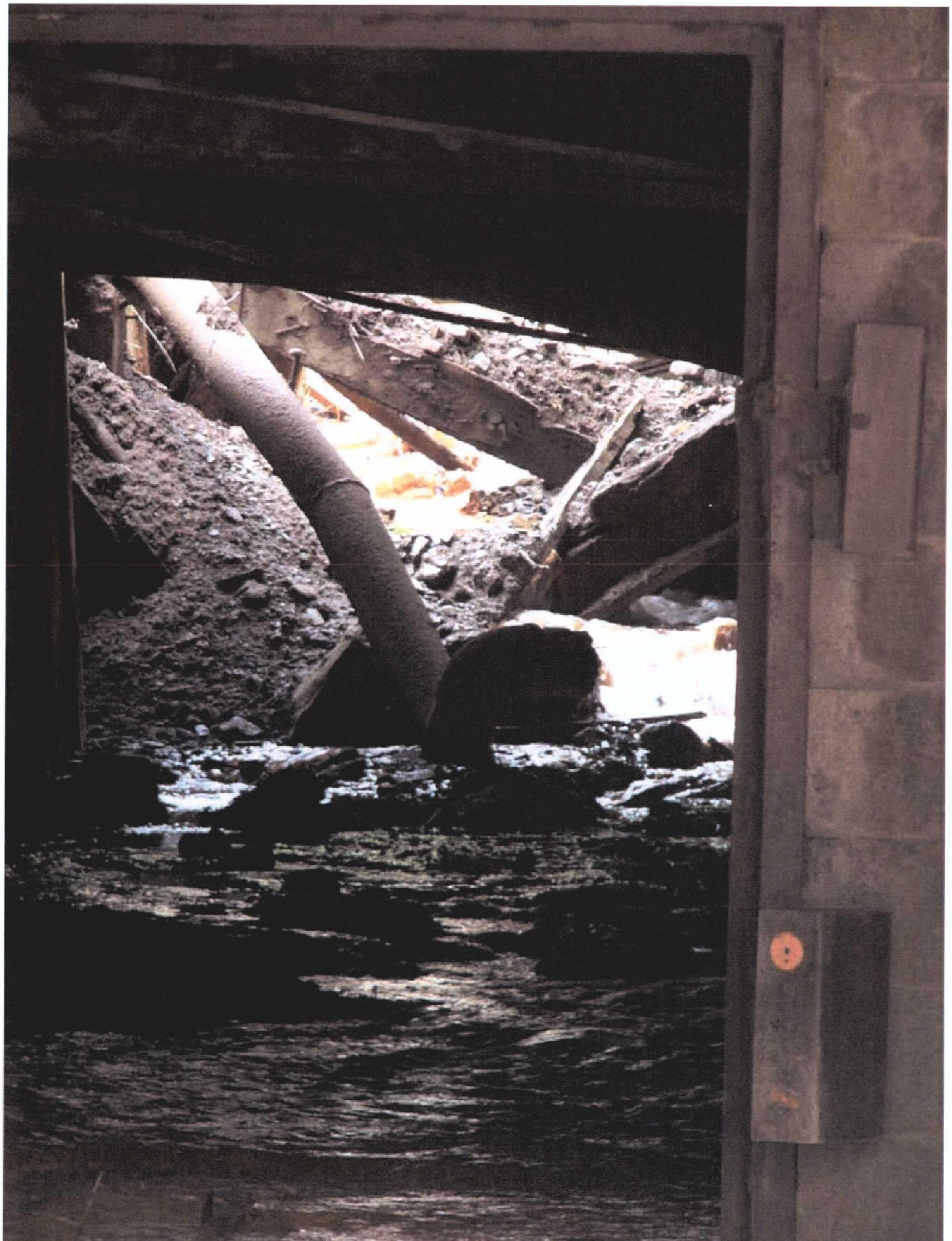

Photo 3 - Collapse at back (up-gradient) of portal structure

Photo 4 - Collapsed adit; view west toward existing portal structure

Photo 5 - Close-up of collapsed adit; note crown timbers and continuous lagging

Photo 6 - Collapsed adit; view east into CHC Hill; note excavation over tunnel alignment

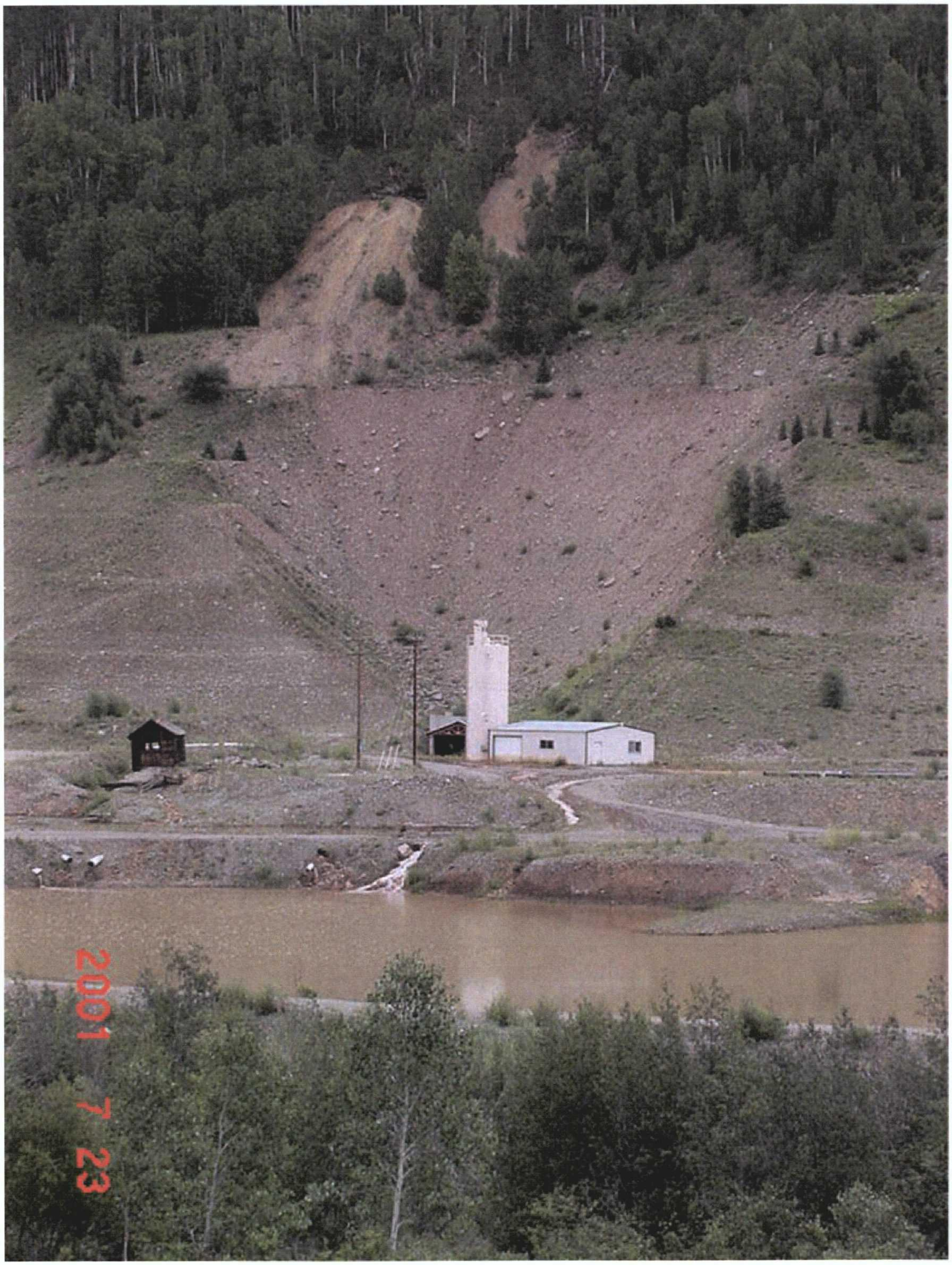

Photo 7 - Excavation over St. Louis Tunnel as of 7-23-01

Photo 8 - Excavation over St. Louis Tunnel alignment; view of northeast part of excavation

Photo 9 - Excavation over St. Louis Tunnel alignment; view of southeast part of excavation